

June 4th, 2021

UC Santa Barbara

Goleta



# Smart Parking Lot

Presented by the Parkingbase Group

**Andrew L, Finn L, Jun C, Luyao H**

Senior CE Students  
College of Engineering, UC Santa Barbara





# Roles



**Andrew Lu**

Gateway Connection  
Web Application Frontend  
and Backend

**Luyao Han**

Sensor Firmware  
PCB Design  
Wireless Charging

**Finn Linderman**

Wireless  
Communication  
Power Management

**Jun Cho**

LoRa Communication  
Virtual Demonstration  
Environment



## Problem Statement

Drivers spend too much time in parking lots trying to find an open space. Many parking lots only have per-floor capacity indicators, and existing solutions are prohibitively expensive.

**What if we could utilize low-cost sensors and a companion application to navigate drivers to empty parking spots faster, at a low cost to facility owners?**



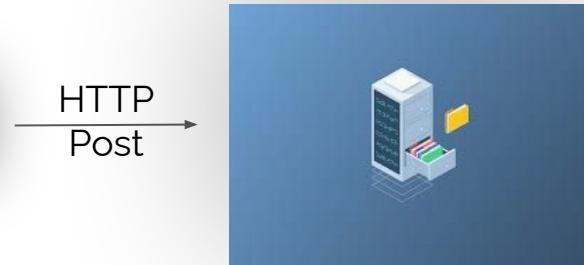
# Parkingbase Overview

The goal is to design a smart parking lot that will direct drivers to the nearest open parking space on campus in an efficient, accurate and clean manner.

We accomplish this using:

- Small, inexpensive parking lot sensors with long-distance and low-power transmission
- Modern, open-source, and cloud-based software solutions
- Easy-to-use mobile interfaces

# System Overview



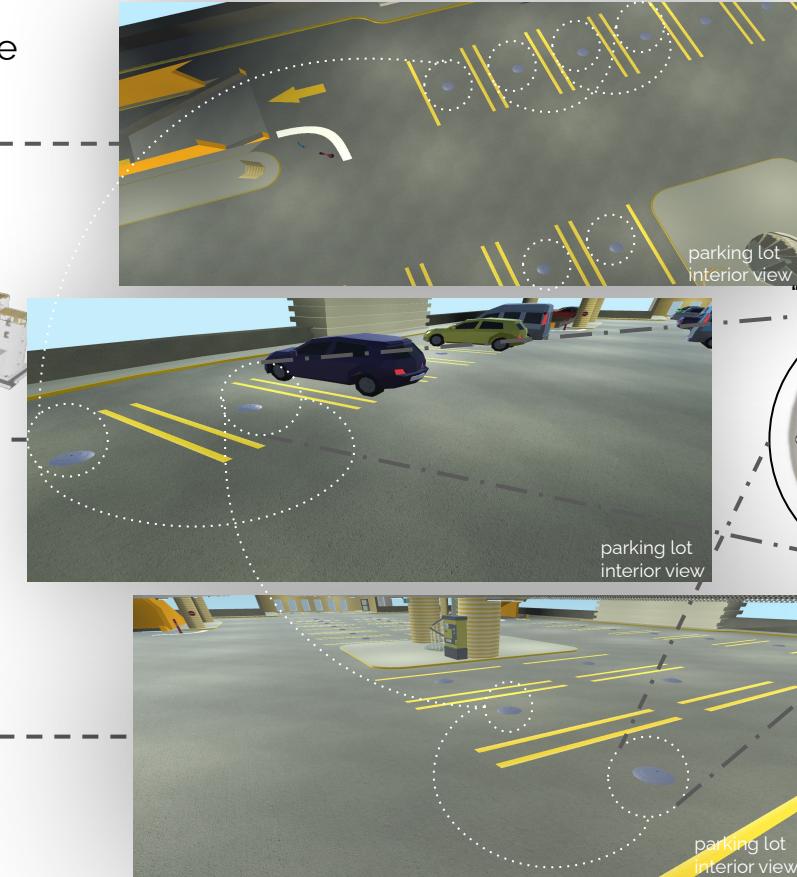
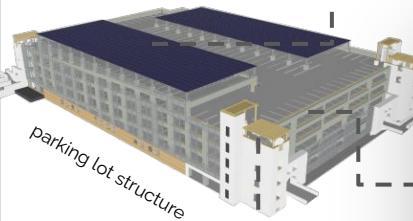
Mobile User Interface



Sensor Unit



## Application Scene





## Parkingbase Sensor Unit



immediate detection of parking status once a vehicle arrives/leaves



long battery life, easy to recharge



long range wireless capability

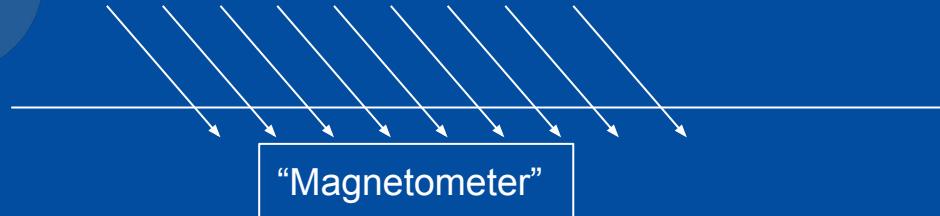


Sensing the car

1. Magnetic
2. Time-of-Flight



# Magnetometer Sensor Reading: Arrival of a Vehicle

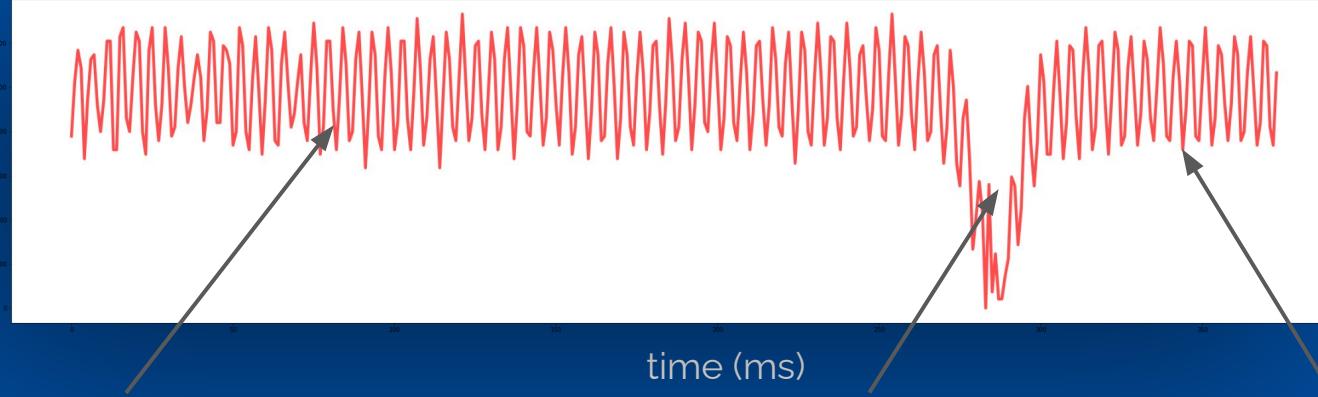




# Magnetometer Sensor Reading: Arrival of a Vehicle

Magnetic Field Strength Reading

field (nT)



Earth Magnetic Field

time (ms)

Engine Detection

Vehicle Stops

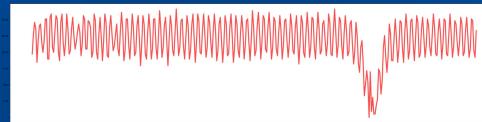




# Magnetometer Sensor Reading: Arrival of a Vehicle

Magnetic Field Strength Reading

field (nT)



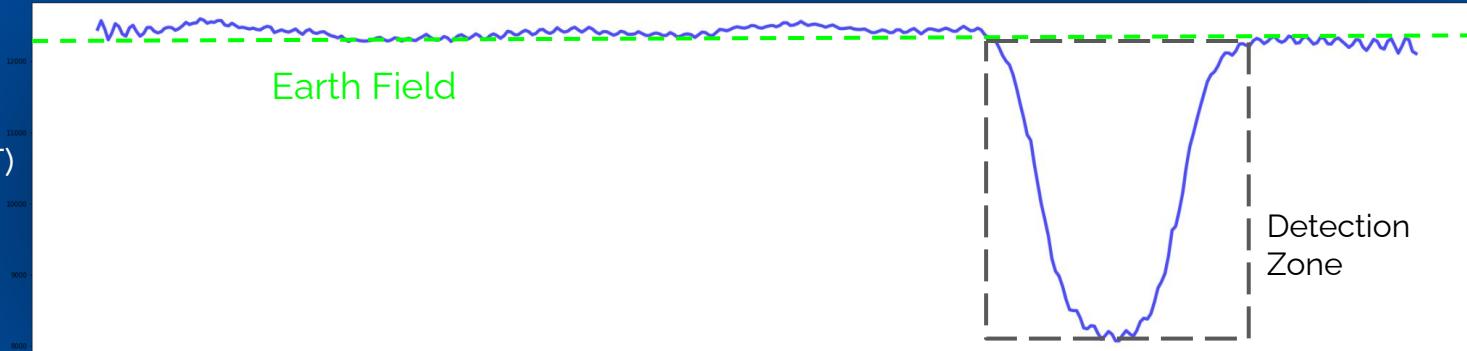
Averaging Filter



Magnetic Field Strength Reading (after filtering)

field (nT)

Earth Field



time (ms)

Detection  
Zone



## Parkingbase Sensor Unit

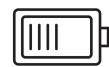


immediate detection of parking status once a vehicle arrives/leaves



Sensing the car

1. Magnetic
2. Time-of-Flight



long battery life, easy to recharge



Low Power (3 year)  
Wireless Recharge



long range wireless capability

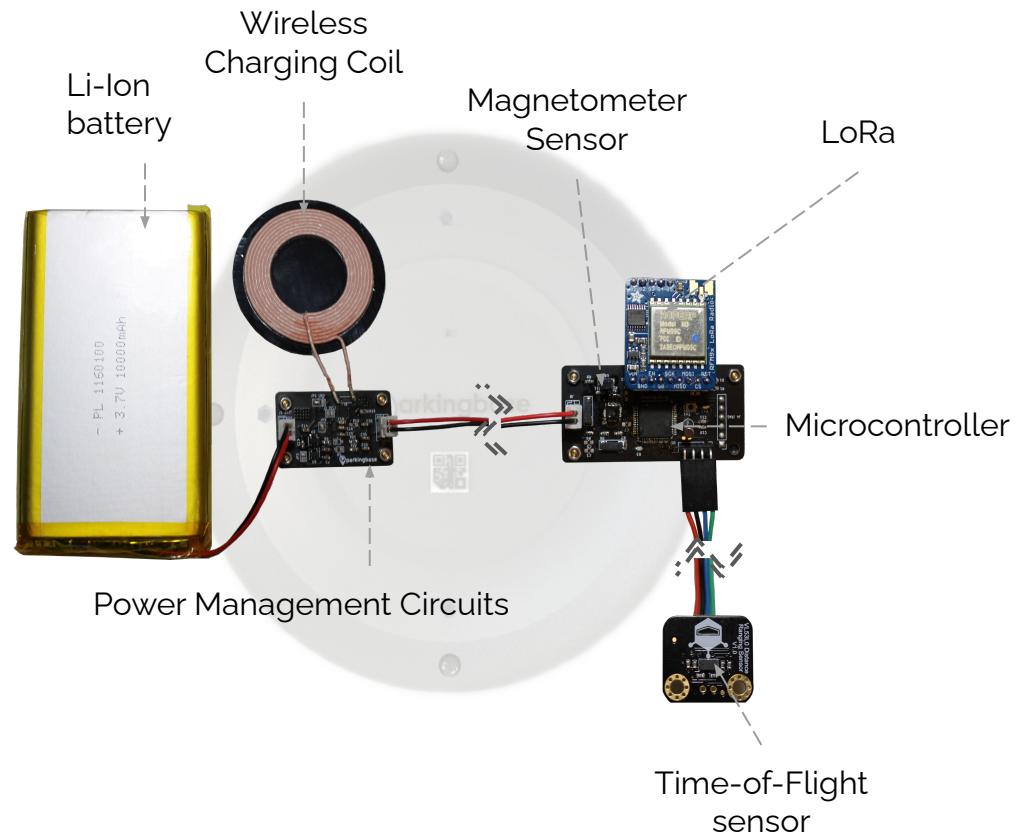
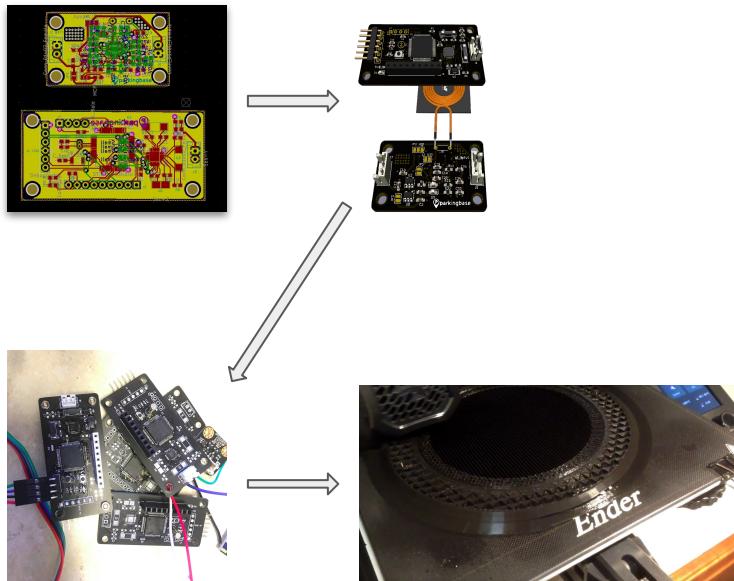
Parkingbase Sensor Unit

Off-market Wireless Charge



# PCB Assembly

- Designed with Kicad
- ~ 30 mm x 50 mm
- Estimated Power Consumption: 22 mA peak
- 4-layer PCB



# Parkingbase Sensor Unit -Decomposition View



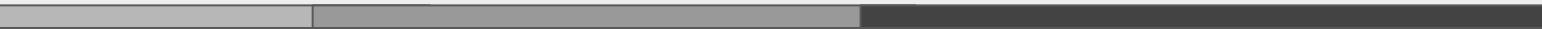
Sensor Testing

PCB  
Layout

Function  
Verification

Firmware  
Integration

Assembly

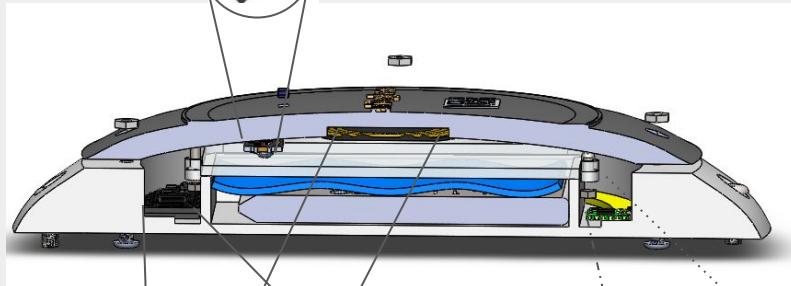


Fall 2020

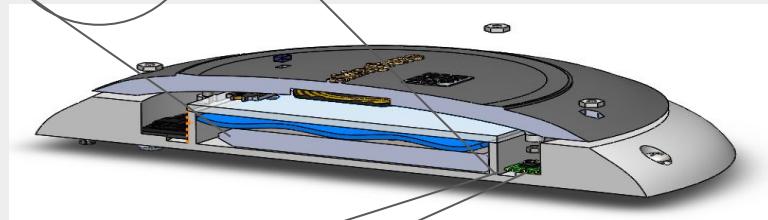
Winter 2021

Spring 2021

time-of-flight sensor



Li-Ion  
battery



Wireless  
Charging Coil

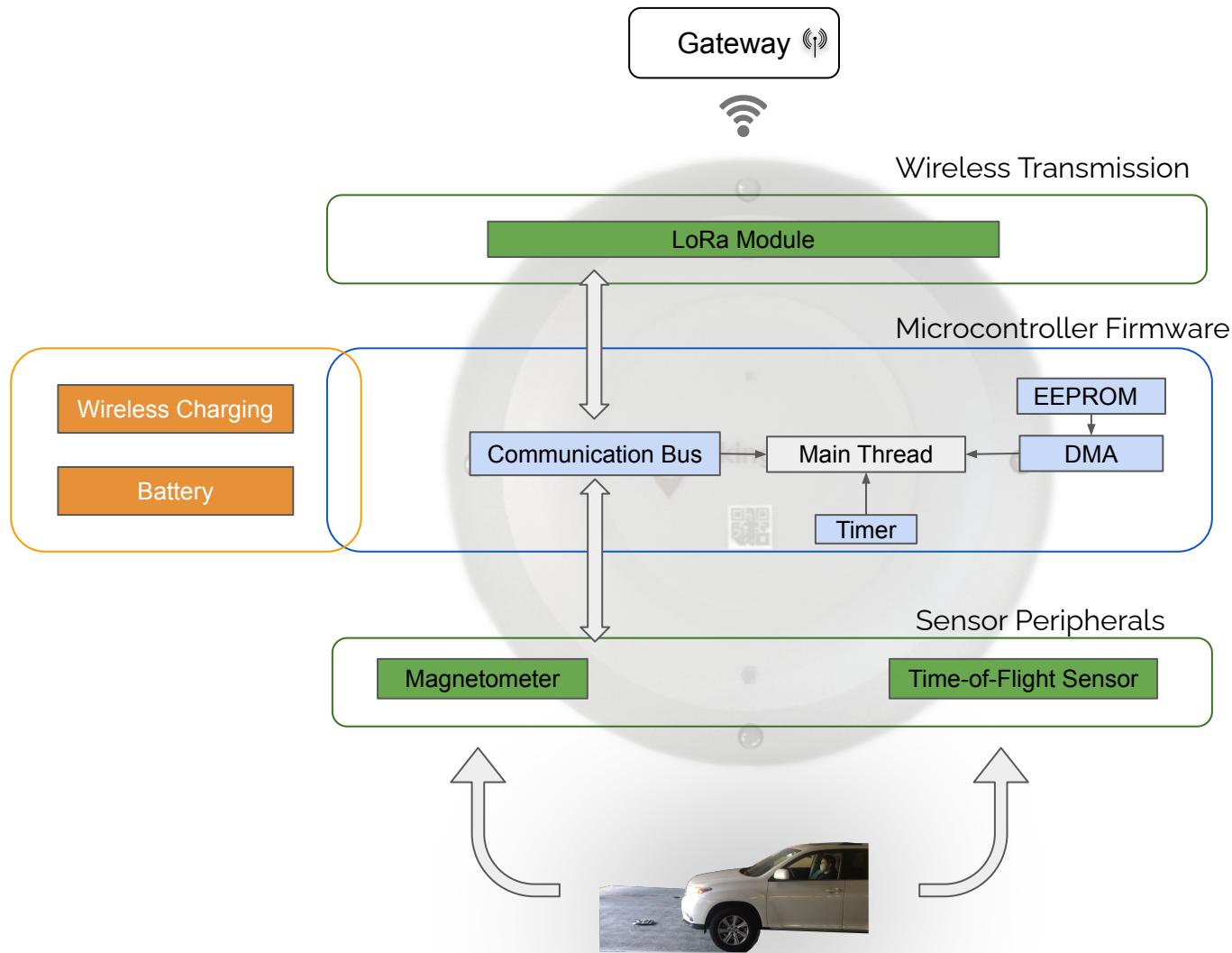


Power  
Management



Vehicle Sensing  
LoRa  
Transceiver







## Parkingbase Sensor Unit



immediate detection of parking status once a vehicle arrives/leaves



Sensing the car

1. Magnetic
2. Time-of-Flight



long battery life, easy to recharge



Low Power

Wireless Recharge



long range wireless capability



LoRa



Wireless  
Communication



# *Selection Criteria*

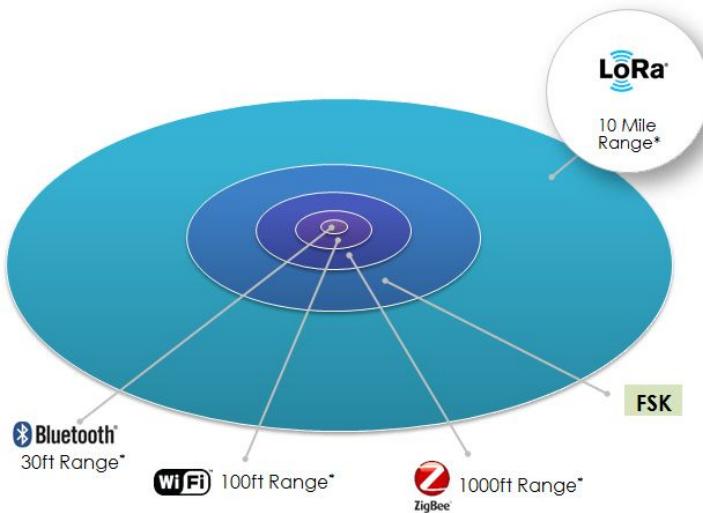
## Problem Requirements

- Long range
- Low power consumption
- High scalability

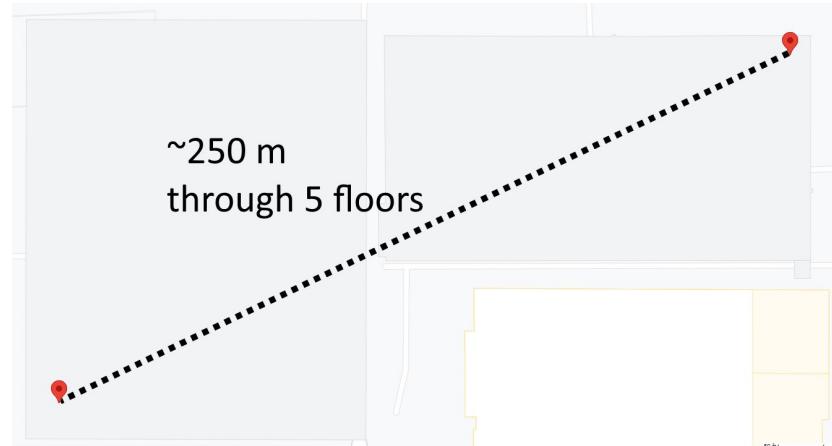
Our Solution: LoRa



# LoRa - Range

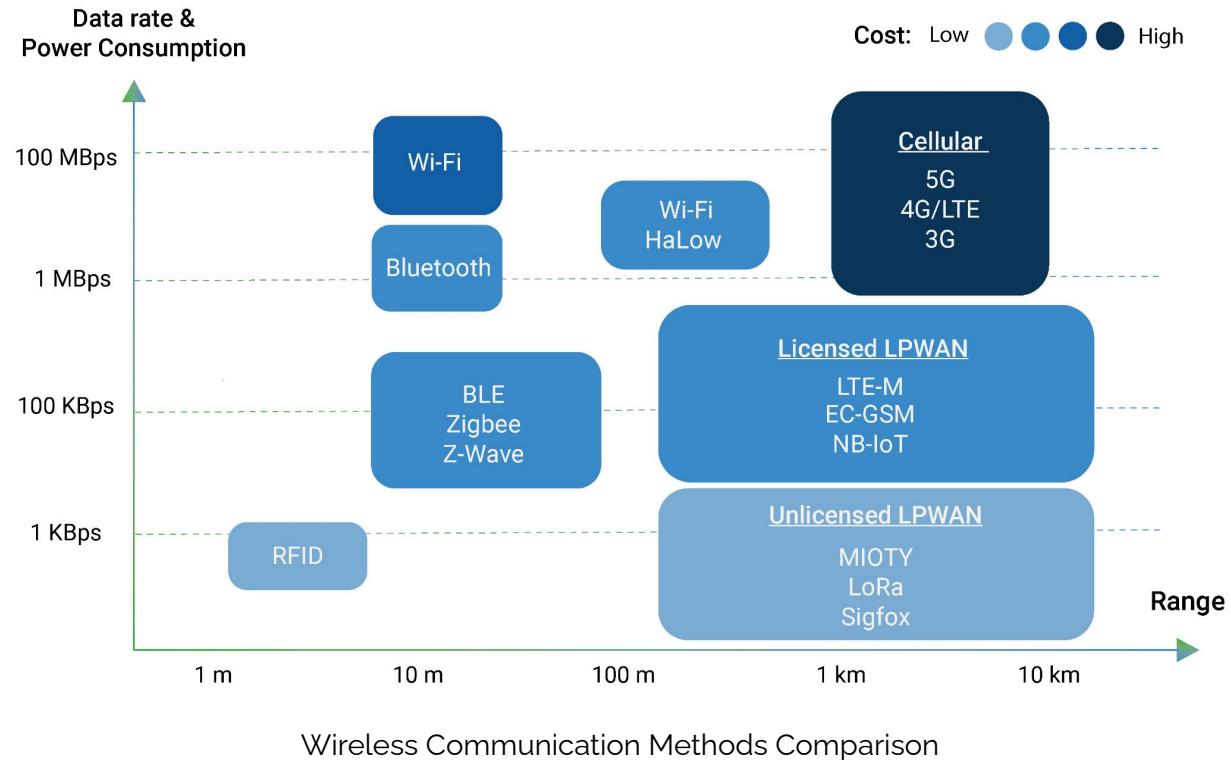


Theoretical range comparison



Live testing in parking structure

# Wireless Communication Comparison





# Gateway

- Raspberry Pi Version 4
- Using RFM9x Library
- Connected to MongoDB backend
- Transmits:
  - Parking Space
  - Status
  - Time Stamp

RFM95 Module





# Data Flow to Gateway

End Node  
lora\_001



915 MHz

Data

Data

ACK

Gateway @ 915 MHz



Data  
HTTP  
Post

Database





User  
Interface



# Driver User Interface

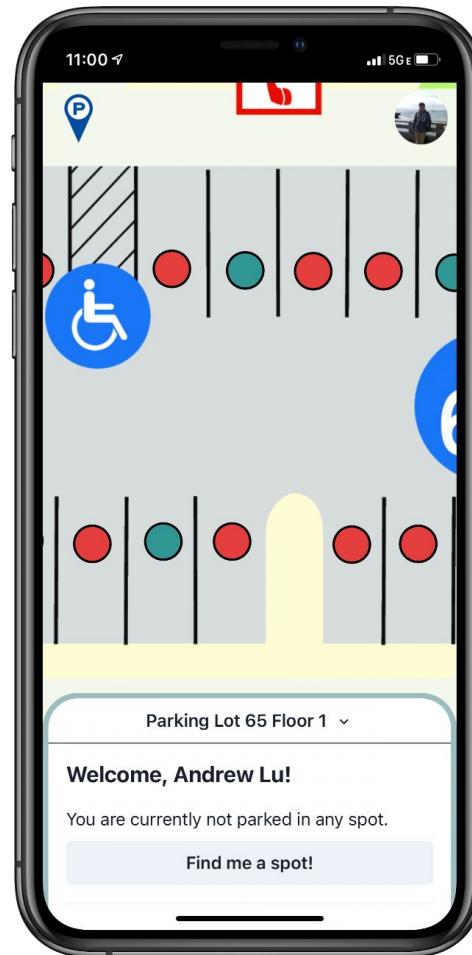
View the status of all spots  
within a parking lot





# Driver User Interface

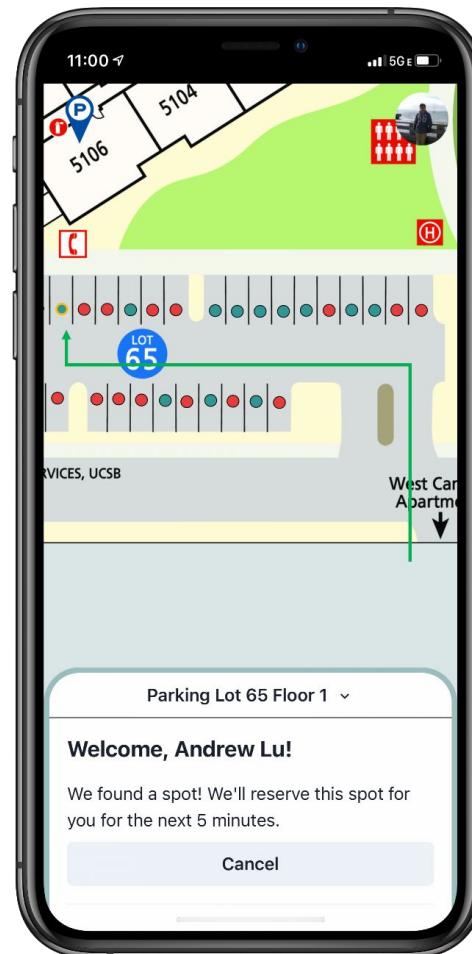
One tap to find and reserve  
an open spot





# Driver User Interface

App will navigate you to  
your reserved spot





# Driver User Interface

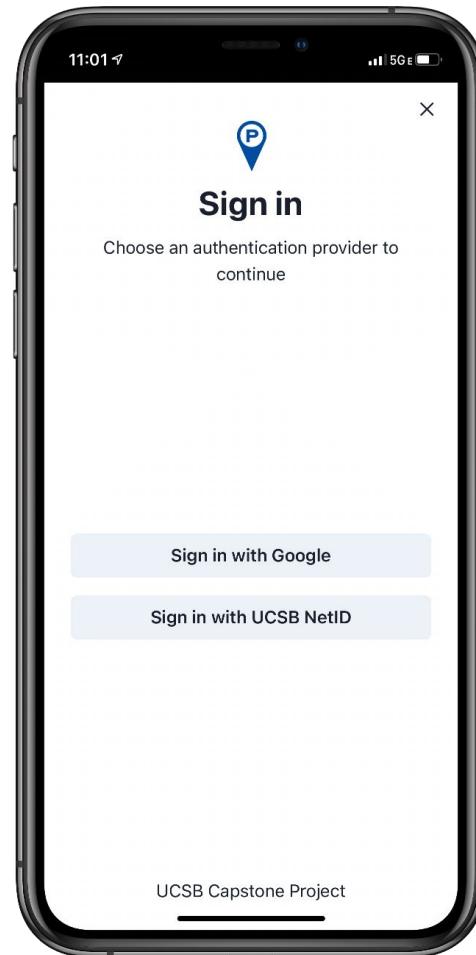
Remembers where you parked -  
view your parking history





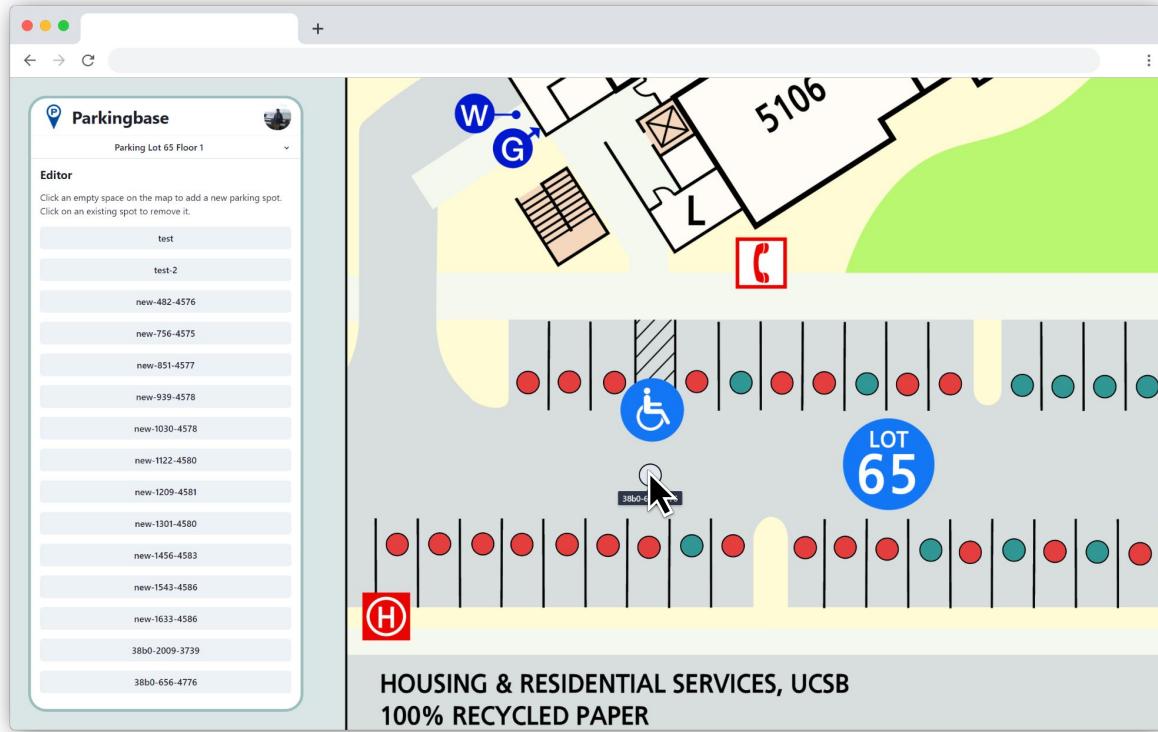
# Driver User Interface

Supports Google and  
UCSB NetID login





# Admin User Interface



Add and remove parking lot sensors with one click on the map.

Usable on any web browser.



# Software Frameworks / Technologies

- Progressive Web Application (PWA)
  - Works on all iOS and Android devices and looks like a native app
- Frontend built using React and Chakra UI
- Backend built using Next JS and deployed on Vercel
- Application database built using MongoDb

~~NEXT~~.js

 chakra

 mongoDB®



## Questions

Acknowledgements

Professor **Yogananda Isukapalli**

Teaching Assistants **Boning Dong, Trenton Rochelle**

